HYDRAULIC VACUUM PUMP

Field of Invention

This invention relates to vacuum pumps and more particularly to a vacuum pump employing a "barometric leg".

Background of Prior Art and Prior Art.

Hydraulic compressors utilizing a column of falling water, a so-called "barometric leg", for compressing air without the use of any mechanical moving parts have been in use throughout the world for more than one hundred years. Usually a natural fall of water is employed to provide compressed air in volumes up to about 30-50,000 cubic feet per minute at gage pressures up to about 130 psi, usually for such purposes as mine ventilation. One of the most successful of several designs is known as a "Taylor Hydraulic Compressor" which is described in "The Mechanical Engineers Handbook", 4th Ed, 1941, pp1914-1915, McGraw-Hill Book Company. Numerous US and foreign patents have been granted on such hydraulic compressors. Essentially, air from an infinitely large open source is sucked through an aerator and down a barometric leg by water, from a natural source such as a waterfall, into a closed container at the bottom of the fall. Compressed air is withdrawn from the container and the water flows to a wastewater outfall. In situations where a natural fall of water is not available, water may be pumped by external means from a reservoir to the top of an aerating apparatus where air is entrained in a column of water

falling therefrom back to the reservoir. Attention is directed to US Patent 2.013,236 granted to N.E. Dell on 3 September 1935 for details of one such externally powered apparatus. There are, however, many industrial operations, such as dewatering and thickening in the mining and papermaking industries, that require the use of substantial vacuums of the order of 25"Hg gage pressure, and vacuum pumps to achieve this level of vacuum commonly require the use of electric motors of the order of 200HP or more. It has now been found that a vacuum pump system employing a barometric leg can produce the desired 25"Hg vacuum, using only a 15HP electric motor to drive the water pump required to raise the necessary water.

Object of Invention.

An object of the present invention is to provide a closed system vacuum pump, incorporating a hydraulic or barometric leg, which can provide a vacuum of the order of 20-30"Hg gage pressure with minimal motive power.

Brief Statement of Invention.

By one aspect of this invention there is provided an apparatus for producing a vacuum, comprising:

a closed vessel having a gas inlet means, liquid inlet means and liquid outlet means;

an open vessel, arranged in vertical spaced relationship below said closed vessel, and having liquid inlet means, gas outlet means and liquid outlet means;

tubular means between said liquid outlet means in said closed vessel and said liquid inlet means in said open vessel so as to provide a fluid flowpath therebetween;

pump means between said liquid outlet means in said open vessel and said liquid inlet means in said closed vessel arranged so as to circulate liquid from said open vessel to said closed vessel; and

aerator means in said closed vessel arranged so as to entrain gas from said gas inlet means in said liquid flowing in said fluid flowpath between said closed vessel and said open vessel.

By another aspect of this invention there is provided a method for creating a vacuum comprising:

providing a closed vessel having a gas inlet means, liquid inlet means and liquid outlet means;

an open vessel, arranged in vertical spaced relationship below said closed vessel, and having liquid inlet means, gas outlet means and liquid outlet means; tubular means between said liquid outlet means in said closed vessel and said liquid inlet means in said open vessel so as to provide a fluid flowpath therebetween;

pump means between said liquid outlet means in said open vessel and said liquid inlet means in said closed vessel arranged so as to circulate liquid from said open vessel to said closed vessel; and

aerator means in said closed vessel arranged so as to entrain gas from said gas inlet means in said liquid flowing in said fluid flowpath between said closed vessel and said open vessel;

operating said pump means so as to raise liquid from said open vessel to a level adjacent an upper end of said aerator means and circulate liquid through said fluid flowpath;

opening said gas inlet means so as to admit gas to said aerator means and thereby become entrained in said liquid flowing in said fluid flowpath; and releasing said entrained gas from said open vessel.

Brief Description of Drawings.

Fig. 1 is a sketch of a vertical sectional view of an apparatus according to one embodiment of the present invention;

Fig. 2 is an enlarged side sectional view of the aerator section of the apparatus of Fig.1, taken along line 2-2 of Fig.3; and

Fig. 3 is a plan view of the aerator of Fig. 2.

Detailed Description of Preferred Embodiments.

In Fig 1 there is shown an upper, closed, liquid containing vessel 1 having a gas, generally but not essentially air, inlet valve 2 which may be connected to a vacuum line (not shown), and a liquid inlet 3 through which the working liquid, usually, but not essentially, water, may be introduced to vessel 1. Vessel 1 includes an aerator device 4, described in more detail hereinbelow, and is provided with a hydraulic leg 5 which projects through the bottom 6 thereof. Hydraulic leg 5, which is generally 20-40 feet long and

preferably about 35 feet long, comprises a tubular member 7 having a substantially conical open upper end 8 terminating adjacent a lower end of aerator 4, and an open lower end 9 terminating in a lower, open, liquid containing vessel 10. A liquid outlet 11 is provided in vessel 10 and connected to a pump 12, generally driven by a motor in the 12-15 HP range. The motor may be of any conventional type such as electric or internal combustion. The pump is connected to a pipe 13 which in turn is connected to liquid inlet 3 so as to complete a fluid flowpath through the system and provide working liquid in the upper vessel 1 to a selected level adjacent the upper end of aerator 4. The selected level may be just above or just below the upper end of aerator 4 depending upon variable operating factors. As seen more clearly in Figs. 2 and 3, aerator 4 generally comprises a plurality of substantially parallel vertical open tubes 14 extending just above or just below the liquid surface 15 in the vessel 1, as discussed above. A hollow, substantially conical head 16 is secured to the top end of tube 7 and forms an upper end thereof terminating below the surface 15 of the liquid in the closed vessel 1.

In operation, water or other liquid is supplied to the lower, open vessel 10 and pump 12 is operated until the upper closed vessel 1 is filled to the operating level 15. Operation of pump 12 is continued and inlet valve 2 is opened, drawing air or other gas from the vacuum line, into the top of the aerator pipes 14 where it is entrained in the vortex of the downwardly flowing water in pipe 7. At the lower end of pipe 7, the entrained air or gas

bubbles off and is permitted to escape at atmospheric pressure, while the water is recirculated by pump 12 back to the closed vessel 1.